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RESEARCH PAPER

Influence of excessive biotic pressure and fire on culm diameter, density flux and seed production in *Melocanna baccifera* stands

F. Lalnunmawia

Department of Forestry, Mizoram University, Aizawl 796001, Mizoram, India

Abstract: A study was conducted to investigate culms density and size, seed size and production rate in *Melocanna baccifera* stands disturbed by biotic pressure and fire. Results revealed that culms density, number and size of seeds produced in the bamboo stands were significantly affected by frequent fire and excessive biotic pressure (collection of young shoots for vegetables and mature culms). The culm density and seed production rate decreased significantly in the stand subjected to excessive biotic pressure. An increasing exposure of culms to sun light was responsible for the above decrease. Seed production rate significantly increased in case of culms subjected to fire in comparison to the control. It indicated that fire stimulated the seed production in *M. baccifera* stand

Keywords: *Melocanna baccifera*; biotic pressure; density; seed production; Mizoram

Introduction

Melocanna baccifera (Roxb) Kurz, Prelim, an evergreen arborescent and monopodial bamboo, belongs to the family Gramineae and grows naturally on dry sandy hill tracts in Northeastern India. Population density of *M. baccifera*, *Dendrocalamus hamiltonii* and *D. longispathus* changes greatly at different fallow periods in Mizoram (Jha and Laha 2002). Population density of *D. hamiltonii* and *D. longispathus* at different felling intensities and height and in a bamboo based agroforestry system in Mizoram has been already studied (Jha et al. 2000; Jha and Laha 2002; Jha and Lalnunmawia 2003; Lalnunmawia et al. 2005).

Reproductive success of plants depends upon fruits and seed setting. Lalnunmawia et al. (2007) reported that the value of seeds production rate was significantly higher in case of *M. baccifera* stands subjected to fire. Troup (1921) observed a very low fruit setting in *M. baccifera.* The low fruit to flower ratio can be inferred to be a consequence of selection to overproduce flowers. Several factors have been proposed to lead to such overproduction in some tropical species by different workers (Cohen and Ducas 1990; Erhlem 1991; Kozlowski and Stearns 1989).

Gregarious flowering of *M. baccifera* is usually followed by death of culms, whereas in case of sporadic flowering the culms do not die. Natural stands of *M. baccifera* is subjected to excessive human pressure in Mizoram due to high demand of young shoots for vegetables and mature culms for other uses. Besides, the natural forest of *M. baccifera* in Mizoram is frequently disturbed by wild fire causing loss of the culms. Thus the present study is designed to study the influence of excessive biotic pressure (collection of young shoots for vegetables etc.) and fire on the culms density and size, seed size and production rate.

Materials and methods

The present study was conducted in a natural bamboo forest dominated by *M. baccifera* at Tanhril forest, Mizoram (India). The study site is situated at an altitude of 840 m above mean sea level and geographically lies at 23°43'N latitude and 92°39'E longitude. Plant species viz. *Imperata cylindrica, Mikenia scandens, Spilanthes sp*. etc and trees species like *Schima wallichi* etc. are growing in association with *M. baccifera*. Thus forest area dominated by *M. Baccifera* were selected and demarcated with representative sites influenced by growing stock (i) subjected to excessive biotic pressure, (ii) disturbed by frequent fire and (iii) normally. Within each category, three quadrats (5 m × 5 m each) were laid randomly to study the density and basal diameter of culms, quantity of seed production, and size and weight of the bamboo seed.

Density of bamboo clump was estimated by counting the culm number in each quadrate. Numbers of seeds produced in each culm were also counted in randomly selected culms inside the

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Biography: F.Lalnunmawia (1973-), male, Ph.D in Department of Forestry, Mizoram University, Aizawl 796001, Mizoram, India.
E-mail: mawia_fanai@yahoo.com

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quadrate. Diameters of the bamboo culms were recorded at breast height. Number and diameter of culms, length and weight of the seeds were recorded. The data collected on seed production, and length, diameter and fresh weight of fruits with three replications in each site were subjected to statistical analysis. Furthermore, the significant independent and interaction effects of different site conditions and replications were analyzed (on the assumptions of post-hoc mean comparisons) to mark out the patterns of mean difference existing therein.

Results and discussions

The maximum culm density was observed in undisturbed stand (140.33 number/quadrat), followed by the stands subjected to frequent fire and the minimum in the stand with excessive biotic pressure (82.67 number/quadrat). *M. baccifera* is a moderate light demander. Excessive biotic pressure reduces the establishments of new culms. Thus more canopy opening caused excess exposure of ground surface to sunlight which suppressed emergence of new culms (Jha et al. 2004).

No significant variation were shown in the basal diameter of bamboo culms between growing stock subjected to excessive biotic pressure or frequent fire and normal growing stock. This indicates that disturbance of bamboo stands did not significantly reduce the size of newly emerged bamboo culms. Excessive biotic pressure and fire disturbing stands had significant influence on the number of seed production. The difference in the number of seeds produced per culm between the disturbed (under biotic pressure) and undisturbed (control) stand was significant at 0.05%. The average number of seeds produced per culm in control was higher (12.89 number/culm) than that of disturbed stand by excessive biotic pressure (8.72 number/culm). Likewise the difference in the number of bamboo seeds produced per quadrat (5 m × 5 m) was also significant between the disturbed (unburned) and undisturbed stand. The average number of seed production per quadrat in control was higher (1771.39 number/quadrat) than that of disturbed by biotic pressure (709.84 number/quadrat). Findings indicates that the rate of seed production was significantly influenced by excessive harvest of young shoots for vegetables and mature culms for other purposes (Table 1-3).

Table 1. Difference in growth parameters of *Melocanna baccifera* under different site conditions (3 replications).

Parameters	Undisturbed (Control)	Disturbed (Biotic pressure)	Burned (Subjected to fire)
Culm Density (No. of culms per 25 m^2)	140.33 (±20.03)	82.67 (±23.16)	119.67 (±19.86)
Diameter of culm (mm)	27.4 (±0.39)	23.6 (±0.71)	26.3 (±0.51)
No. of seeds produced in one culm	12.89 (±2.77)	8.72 (±1.23)	16.33 (±6.22)
No. of seeds produced per quadrat (25 m^2)	1771.39 (±299.95)	709.84 (±171.96)	2698.48 (±911.31)
Average diameter of fruits (cm)	5.64 (±0.25)	5.14 (±0.38)	4.54 (±0.13)
Average length of fruits (cm)	8.95 (±0.49)	8.12 (±0.61)	7.08 (±0.28)
Average weight of fruits (g)	118.98 (±6.96)	90.48 (±7.80)	72.35 (±2.78)

Note: Figures in the parenthesis are Standard Deviations.

Table 2. ANOVA table for culm density, basal diameter and number of seed production

Source of variation	Culm Density		Basal dia. of culm		No. of seeds produced in one culm		No. of seeds produced per quadrat	
	F. Ratio	P. Level	F. Ratio	P. Level	F. Ratio	P. Level	F. Ratio	P. Level
UBS X DBS	10.63953	0.031027*	2.385777	0.131702 ^{NS}	8.6327	0.0058*	7.66705	0.00664**
UBS X BBS	0.00015	0.990921 ^{NS}	0.096695	0.75773 ^{NS}	1.1331	0.2946 ^{NS}	46.81349	0.00000**
DBS X BBS	4.09297	0.113096 ^{NS}	0.828725	0.36905 ^{NS}	5.6245	0.0235*	11.98601	0.00077**
UBS X DBS X BBS	3.52905	0.097009*	0.934225	0.399509 ^{NS}	3.8258	0.0283*	20.68064	0.00000**

Note: UBS-Undisturbed bamboo stand; DBS-Disturbed bamboo stand; BBS-Burned bamboo stand; ** Significant at 0.01 level,* Significant at 0.05 level and NS-not significant

Table 3. ANOVA table for diameter, length and fresh weight of bamboo seeds.

Source of variation	Diameter of seeds		Length of seeds		Weight of seeds	
	F. Ratio	P. Level	F. Ratio	P. Level	F. Ratio	P. Level
UBS X DBS	15.5268	0.000144**	7.66705	0.00664**	19.81591	0.000021**
UBS X BBS	56.8042	0.00000**	46.81349	0.00000**	72.0471	0.00000**
DBS X BBS	11.32864	0.001064**	11.98601	0.00077**	10.87535	0.001327**
UBS X DBS X BBS	27.3056	0.00000**	20.68064	0.00000**	32.7745	0.00000**

Similarly, the significant variation in the number of seeds produced per culm was shown between disturbed (excessive biotic pressure) and burned bamboo stand. However, no significant variation occurred at the number of seed production per

culm between the undisturbed and burned bamboo stand (Table 2). This indicates that those stands subjected to fire did not significantly decrease the seed production rate. An increase in the exposure of culms to sun light caused a decline in culms growth and seed production rate. Jha (2001) suggested that *M. baccifera* stand subjected to excessive biotic pressure caused a decline in nutrient and moisture level whereas fire-affected stand showed an increase in the soil nutrient status promoting culms growth. Thus it can be inferred that the above mentioned reasons may be responsible for the decrease in culms growth and seed production rate in the *M. baccifera* stand. Increase in seed production rate in fire affected stand may be attributed to addition of desired nutrients in the form of ash.

The maximum number of seeds produced in one culm was recorded in the fire affected stand (16.33 number/culm), followed by the undisturbed site (Control) (12.89 number/culm) and the minimum in case of the stand with excessive biotic pressure. It suggests that fire had a significantly positive influence on seed production. It has been observed that bamboo fire-affected stands (culms) produced greater amount of seeds. Emergence of more seeds from rhizomes was also recorded. In contrast, the number of seed production per quadrat had a similar comparison result as that in one culm among the fire-affected stand, undisturbed (Control) and disturbed stands by biotic pressure.

The maximum diameter (5.64 cm), length (8.95 cm) and fresh weight (118.98 g) of fruits was recorded in control, followed by the stand with biotic pressure, and the minimum in the stand subjected to fire (Table 1). The variation in the diameter, length and fresh weight of seeds in all the study conditions was significant at 0.01%. The diameter, length and weight of seeds were highest in control, followed by the disturbed (biotic pressure) and the minimum in case of the stand subjected to fire. The seeds produced under the undisturbed *M. baccifera* forest were bigger and more uniform in size. Whereas, the culms produced more seeds in bamboo stand disturbed by fire in comparison to other sites.

The bamboo culm density decreased significantly in continuously disturbed stand. The bamboo seed production increased significantly in burnt stand, indicating that fire stimulated the seed production in *M. baccifera.* The present finding may be useful for the sustainable management of bamboo (*M. baccifera*) forest in north eastern region of India.

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